24 TOWER AND AIRPORT SURFACE

Operated by the FAA, the Department of Defense (DOD), contractors to the FAA, and nonfederal organizations, airport traffic control tower (ATCT) facilities are primarily responsible for ensuring sufficient runway separation between landing and departing aircraft. ATCTs also relay instrument flight rules (IFR) clearances, provide taxi instructions, and assist airborne aircraft within the immediate vicinity of the airport.

The concept of operations (CONOPS) calls for integrating arrival and departure services with airport surface operations. Future tower and airport surface capabilities include:

- Improved information exchange and coordination activities, including expansion of data link capabilities to more users at more airports

- Automation to enhance the dynamic planning of surface movement, balancing runway demand, and improving the sequencing of aircraft to the departure threshold

- Automation to improve the identification and predicted movement of all vehicles on the airport movement area, including conflict advisories

- Safety and efficiency enhancements by planning an aircraft's movement such that a flight can go directly from deicing to takeoff without risk of requiring another deicing cycle due to taxi delays

- Integration of surface automation with departure and arrival automation so that the arrival runway and taxi route are optimally assigned with respect to the gate assignment (Current and projected areas of congestion on the surface, runway loading, and environmental constraints will also be taken into consideration.)

- Increased collaboration and information sharing among users, service providers, and airport management to create a more complete picture of airport demand.

The goal in the tower/airport surface domain is to improve the exchange of information not only between service providers and actively controlled aircraft but also among all users located at the airport. This exchange will enhance operational efficiency and safety of aircraft movement on the airport surface.

This section describes the capabilities and associated systems that are envisioned as part of the architecture for the tower/airport surface domain. It focuses on the evolution of automation in ATCTs. The evolution and expansion of data link services in the airport environment was described in Section 17, Communications. The airport architecture is discussed in Section 28, Airports.

Figure 24-1 depicts the future ATCT architecture for high-activity towers, which includes the following components:

- Controller workstation networks

- Dedicated ATCT local area networks (LANs) for transferring data and information between facilities

- Enhanced next-generation information display systems (E-IDSs)[1] for consolidating status and control devices in the tower cab

- Upgraded tower display workstations (TDWs) for integrating tactical and strategic decision support applications and facilitating the addition of newer capabilities into tower cabs

- LANs in terminal radar approach control (TRACON) and air route traffic control center (ARTCC) facilities will communicate via aeronautical telecommunications network (ATN)-compatible routers over a wide area network (WAN) with an ATCT LAN.

Low- and moderate-activity towers will have less functionality and a limited number of display types.

ATCT Architecture

Controller Workstations. The long-term goal of the tower architecture is to create a modular workstation with three displays to present alphanumeric data, radar and weather information, and

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1. E-IDS will be developed from the current Systems Atlanta Information Display System (SAIDS) and ASOS controller equipment (ACE) functionalities.
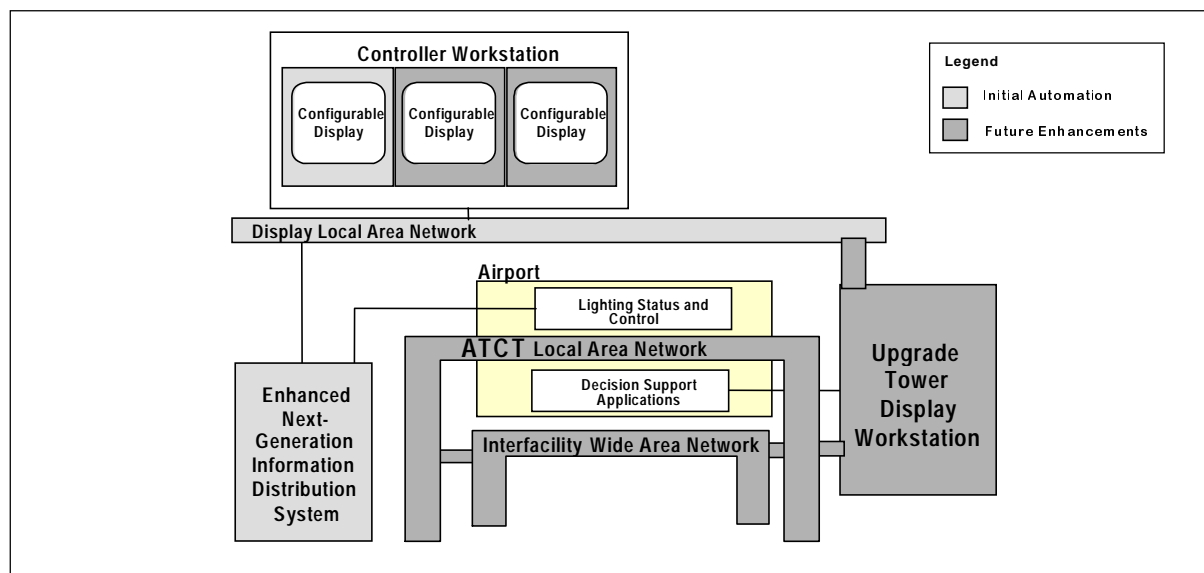
Figure 24-1. Future Airport Traffic Control Tower Functional Architecture

communications access and control information. This basic workstation can be configured to the specific needs of each type of controller position. Many positions in the tower cab do not require three displays. Wherever possible, controller workstations will be configured to reduce the number of displays. The clearance delivery position, for example, might use a single display for predeparture clearance (PDC) delivery information and for communications access and control. The local controller will likely have one display for airborne traffic, another for surface traffic, and a third display presenting consolidated status and control information. Some displays may incorporate touch-screen and/or voice recognition capabilities to reduce the amount of heads-down time spent on keyboard and trackball data entry.

Automation Enhancements. Data and information will be processed to provide new services and improve existing services displayed on the tower color display, which is suitable for high ambient light conditions. New applications will include integrating and rehosting existing functions onto controller displays.

NAS users outside the tower (such as airport managers, airline dispatchers, and ramp controllers) who need access to NAS information will connect with the tower LAN and, where appropriate, over the interfacility WAN. Access to the WAN will be restricted by suitable data security and integrity precautions.

24.1 Airport Traffic Control Tower Architecture Evolution

The ATCT architecture includes the overlapping steps shown in Figure 24-2. Step 1 maintains all currently installed tower systems, including the major ones purchased by regional or airport authorities. The three subsequent steps will replace various devices in the tower cab with new automation, integrating functions in the tower cab and interfacing with the NAS-wide information network, described in Section 19, NAS Information Architecture and Services for Collaboration and Information Sharing.

The first improvement deploys the Airport Movement Area Safety System (AMASS) and the initial surface movement advisor (SMA) to high-activity airports. AMASS detects and alerts tower controllers of actual and potential runway incursions. Initial SMA, as defined for the Free Flight Phase 1 Core Capability Limited Deployment (FFP1 CCLD) (see Section 6, Free Flight Phase 1, Safe Flight 21, and Capstone), provides a one-way feed of aircraft arrival, departure, and status information to ramp control operators.

The existing digital bright radar indicator tower equipment (DBRITE) displays will be replaced by the TDW displays procured under the Standard Terminal Automation Replacement System (STARS) program (see Section 23, Terminal). About the same time, data link delivery of taxi clearances (DDTC) (the prototype currently being
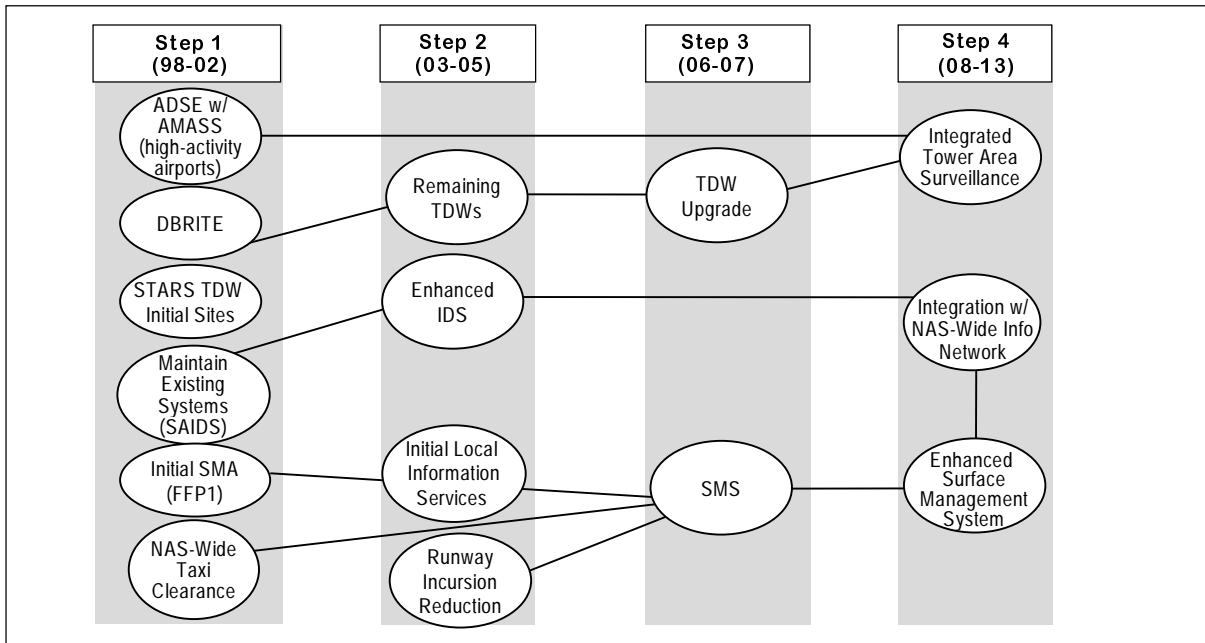
Figure 24-2. Airport Traffic Control Tower Architecture Evolution

evaluated in Detroit) is anticipated to be deployed nationally to provide new capabilities to the ATCT domain. E-IDS will be deployed to consolidate status and control devices in the tower cab.

A fully operational surface management system (SMS), which evolved from the Atlanta airport prototype of the SMA, will be installed at high-activity airports. An upgraded TDW will be implemented in high-activity towers, which will enable controllers in those towers to monitor both surface and airborne traffic via an integrated surveillance display, configurable to the particular needs of the control position in the tower. (Some positions may still use two situation displays—one configured for surface and another configured for airborne.) Subsequent sections describe these transition steps in more detail.

The following paragraphs present the tower and airport surface architecture evolution in more detail. The architecture diagrams show the content of each step in a logical or functional representation without any intention of implying a physical design or solution.

24.1.1 Airport Traffic Control Tower Architecture Evolution—Step 1 (Current–2002)

Figure 24-3 illustrates the first step in the evolution from the current ATCT architecture to the future ATCT architecture. This step establishes a nationally managed maintenance program to improve configuration management and the coordination and maintenance of the many nonstandard tower systems, including those purchased by regional or airport authorities.

The immediate problem addressed in this step is establishing a NAS-level maintenance program for the Systems Atlanta Information Display System (SAIDS). SAIDS is a proprietary display system that provides tower controllers the capability to receive and disseminate locally determined airport information, including weather and airport advisories. It is installed in more than 200 ATCTs and 25 associated TRACON facilities. SAIDS is also installed in more than 300 other facilities—including some ARTCCs, regional FAA offices, flight service stations, military air bases, and non-government facilities.

These systems were not installed under a national program, and all maintenance is performed through commercial contracts. A mission analysis is currently underway to investigate the upgrade of SAIDS to NAS standards, establish configuration control over the system, recognize it as an official FAA program, and integrate it into the FAA's overall NAS maintenance program.

Figure 24-3. Airport Traffic Control Tower Architecture Evolution—Step 1 (Current–2002)

AMASS provides alert information to controllers of potential conflicts between arriving aircraft and surface traffic or between aircraft and vehicles on the surface via audible cautions and warning and visual information superimposed on the airport surface detection equipment (ASDE-3) display in ATCTs.

AMASS is scheduled for deployment to 34 high-activity airports. Prototypes are currently installed at Detroit and St. Louis. AMASS requires a one-way interface to receive data from the terminal automation system. AMASS processes surveillance data from the terminal automation system (automated radar terminal system (ARTS) and/or STARS), ASDE-3, and the airport surveillance radar-model 9 (ASR-9) to define the position, direction, and velocity of all airport targets.

A redefined initial SMA will be implemented as part of FFP1 CCLD to achieve early benefits to ATC and NAS users by providing a form of limited collaborative decisionmaking capability. Specifically, initial SMA for FFP1 CCLD will provide aircraft arrival information through the terminal automation system (ARTS and/or STARS) to airline ramp control operators.

During this step, TDW displays procured under the STARS program will begin to replace DBRITE displays.

Data from all local weather sensors/processors (terminal Doppler weather radar (TDWR), low-level windshear alert system (LLWAS), runway visual range (RVR), automated surface observing system (ASOS), and the airport surveillance radar–model 9 (ASR-9) weather channel) will begin to be available from the TRACON-installed integrated terminal weather system (ITWS) at 45 high-activity airports. From these sources, ITWS will provide both tower and terminal service providers with a set of airport weather products, including warnings of the most severe forms of windshear, turbulence, thunderstorm, heavy snow, and aircraft icing potential hazards (see the discussion on weather systems in Section 26, Aviation Weather).

Transmission of taxi clearances via data link (the DDTC prototype is currently being evaluated in Detroit) is expected to be deployed nationally. During this transition period, PDCs and digital automatic terminal information services (D-ATIS) will continue to be provided over the aircraft communications addressing and reporting system (ACARS) via ARINC.

PDC assists the tower clearance delivery specialist in composing and delivering departure clearances. The automatic terminal information service (ATIS) equipment enables controllers to formulate ATIS text messages for delivery. The ATIS text messages are then delivered to flight crews
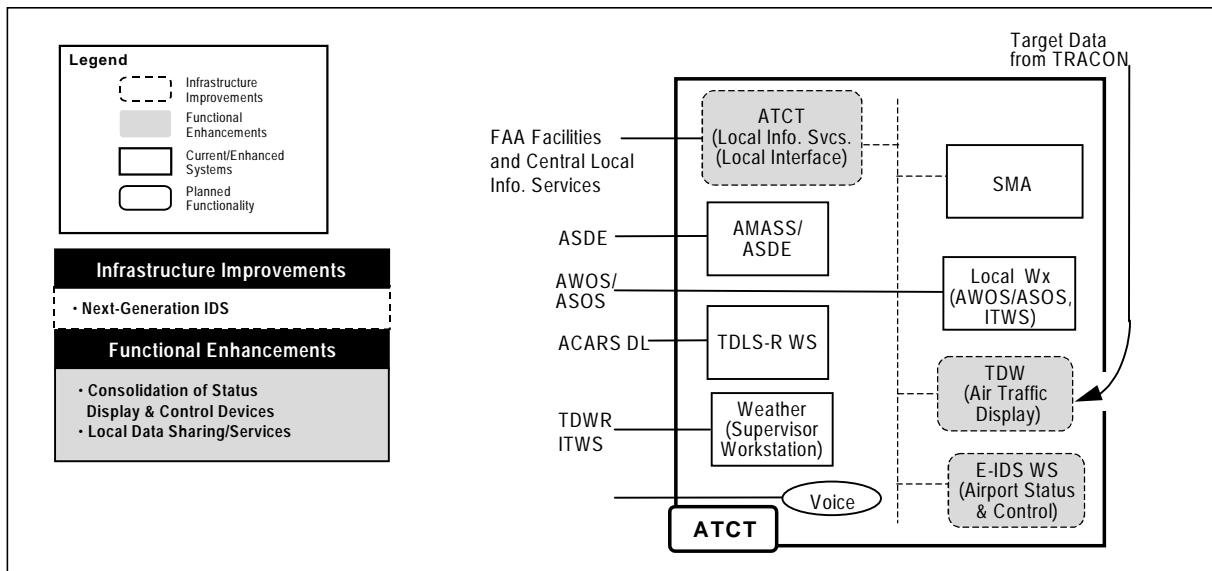
Figure 24-4. Airport Traffic Control Tower Architecture Evolution—Step 2 (2003–2005)

via ACARS data link. An ATIS automatic voice generation function produces spoken broadcasts using a synthesized voice to read the ATIS message.

24.1.2 Airport Traffic Control Tower Architecture Evolution—Step 2 (2003–2005)

Figure 24-4 depicts the transition during Step 2. The TDW will have replaced most remaining DBRITEs.

E-IDS will be implemented to reduce the number of displays and data entry devices. E-IDS uses an open system architecture to integrate the functionality of SAIDS and ASOS controller equipment (ACE), centralize the status indicators and control of airport lighting systems, eliminate multiple manual panels scattered throughout the tower cab. E-IDS will increase the timeliness and quality of weather, traffic, and system status data for service providers as well as the quality of services for users.

Based on lessons learned from initial SMA, users and service providers will determine whether national deployment is beneficial.

New runway incursion reduction capabilities will be implemented to help reduce the possibility of traffic conflicts; this includes additional surveillance, ATC tools, signage, lighting, new procedures, and increased training. The installation of a new surface surveillance/conflict detection sys-

tem for additional airports that do not have ADSE/AMASS is expected to begin.

The first increment of local data-sharing services will enable all intrafacility systems to share common data.

24.1.3 Airport Traffic Control Tower Architecture Evolution—Step 3 (2006–2007)

This step begins the enhancement of the local information services in preparing for the NAS-wide information network, upgrades the TDWs, and initiates a next-generation SMA called a surface management system (SMS) (see Figure 24-5).

As local legacy systems are replaced or new systems developed, commercial data base management systems will be used where applicable and models of information for all systems will be based on managed data standards. The NAS-wide information network will evolve from local information data exchange to interfacility information exchange. Structured data will be accessible by external applications. The NAS information network will provide information to both users and controllers, taking into account necessary security policies and precautions.

High-activity towers will begin to receive an upgraded TDW that will accommodate selected additional data entry and display. The TDW will be used to display a mixture of terminal and surface information (see Section 23, Terminal). Tower controllers will be able to monitor both surface
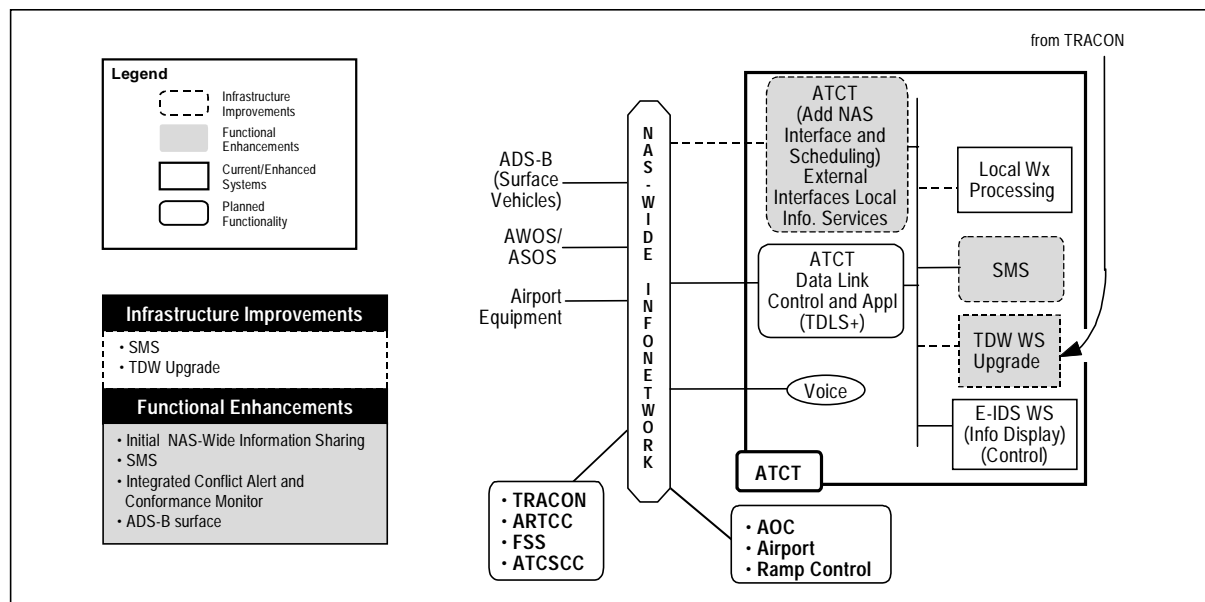
PART III

Figure 24-5. Airport Traffic Control Tower Architecture Evolution—Step 3 (2006–2007)

and airborne traffic via integrated surveillance displays, configurable to the particular needs of the control position in the tower. Surface traffic will be displayed with a perimeter "look-ahead" for airborne traffic. Airborne traffic may be displayed with an inset for runway and adjacent taxiway activity.

A next-generation SMS will be deployed at selected high-activity airports. The exact features of SMS have yet to be defined, but it will include enhanced decision support to aid movement sequencing and scheduling in conjunction with TRACON operations.

The tower data link services (TDLS) will automate tower-generated information for transmission to aircraft via data link. The TDLS interfaces with sources of local weather data and flight data and provides PDCs and D-ATIS.

24.1.4 Airport Traffic Control Tower Architecture Evolution—Step 4 (2008–2015)

Early in this step, airports will have access to the NAS-wide information network to provide complete data connectivity among service providers, airline operation centers (AOCs), airport operators, and airport emergency centers (see Figure 24-6).

In the far term, ATCT surveillance will be provided by the all-digital system that was developed from the terminal surveillance data processor (SDP), which was described in Section 23, Terminal. Surveillance data from all sensors and systems covering airborne and surface vehicles will be fused, creating a track file for use by all automation functions. This front-end surveillance processor function will produce a synergetic surveillance data base, permitting automation functions that use "best quality" surveillance data for specific purposes.

The introduction of the Local Area Augmentation System (LAAS) for the Global Positioning System (GPS) and automatic dependent surveillance (ADS) data will greatly increase the accuracy of position data from both surface vehicles and aircraft traffic

The enhanced SMS will be fully integrated into the automation platform provided by the TDW upgrade for surface planning and monitoring. The SMS will contain information on environmental and operational conditions at the airport and send updates to the NAS-wide information network. The SMS and NAS-wide information network inform service providers of all arrival, surface, and departure schedules. The systems also interface with surface and airborne surveillance information, flight information, weather, and traffic management systems. This data sharing at the airport allows service providers to coordinate local operations with airline ramp and airport operators, improving airport operations. SMS will integrate
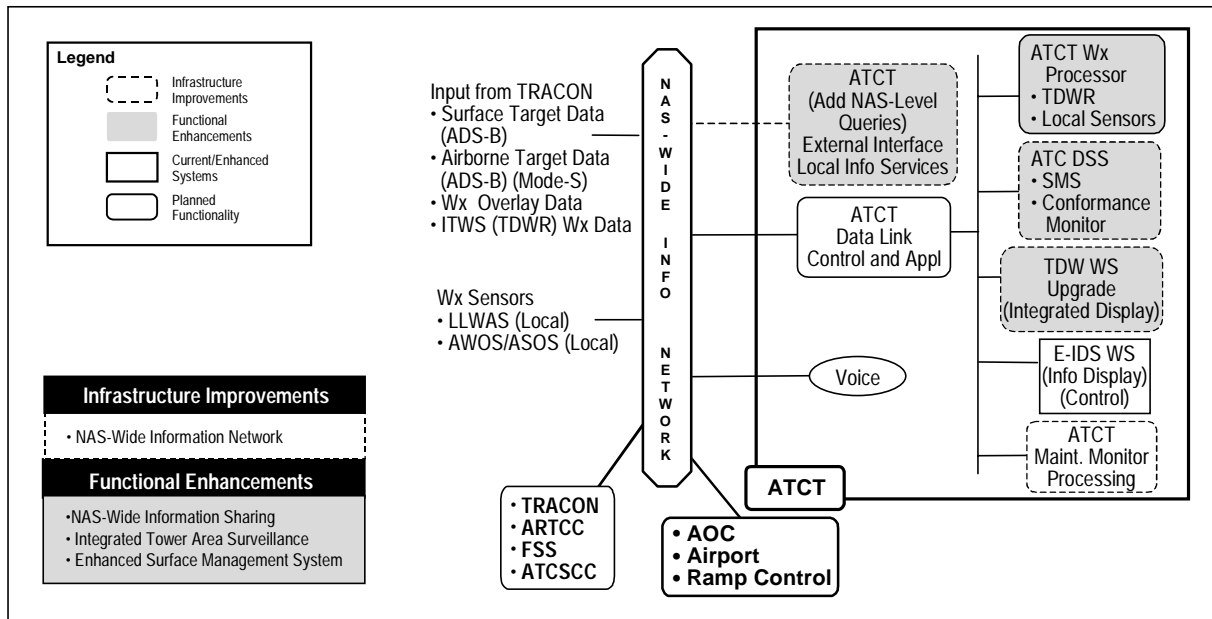
Figure 24-6. Airport Traffic Control Tower Architecture Evolution—Step 4 (2008–2015)

planning functions, providing an expanded conformance monitoring and probe function that could data-link an alert directly to the cockpit.

All these automation systems will support monitoring, routing, and timing of aircraft surface movement and will be fully integrated with the flight data, traffic management, and local weather system functions. Surface map displays of automated surface movement safety and guidance information will be available in both the tower and cockpit to enhance coordination.

Flight data processing will be integrated with real-time tower operations. Conflict detection will be available for integrated terminal and surface operations; the information will be displayed in towers and TRACONs. Finally, improved metering, sequencing, and spacing aids will be used for arrivals and departures, which will increase airport capacity and improve surface operations.

Data link services in the tower/airport domain will evolve from services developed for the en route and terminal domains. Thus, until this step, data link services continue to involve only the uplink of information to aircraft and require no reply from the flight deck.

As data link evolves, the capability for controller-pilot dialogue to communicate strategic and tactical air traffic service messages that are currently conveyed by voice will be implemented and may be transitioned to the tower domain depending on their success. A ground-based processor will receive a downlinked request from the flight deck, compile the requested information, and uplink it to the aircraft for display. Next, data link will facilitate the downlink of weather and aircraft state-and-intent information to improve the prediction capabilities of decision support and weather systems.

24.2 Summary of Capabilities

The summary of the tower/airport traffic handling capabilities is depicted in Figure 24-7. These capabilities will be enhanced by removing constraints to aircraft movement, from gate pushback to the runway and from landing rollout to the gate. Airport surface movement operations and information exchange coordination will be facilitated by the expanded use of data link capabilities and the incorporation of cockpit avionics (e.g., GPS/automatic dependent surveillance broadcast (ADS-B)) to display airport surface position and other traffic. This will provide cockpit crews with improved situational awareness and conflict advisories so that they can conduct all-weather, low-visibility taxi operations. The NAS will also feature enhanced decision support tools designed to improve planning of airport surface movement, balancing runway arrival/departure demand, and
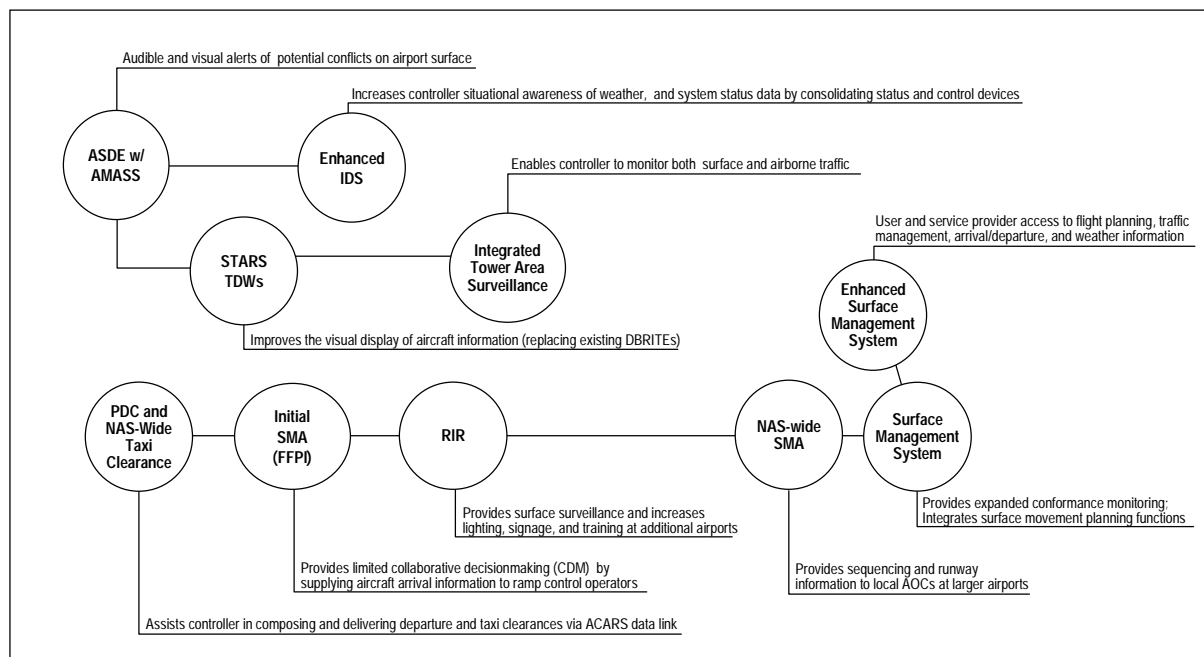
Figure 24-7. Tower and Airport Surface Capabilities Summary

sequencing of aircraft by performance type to the departure runway.

The integration of tower/surface automation with the terminal arrival/departure automation systems will also help relieve congestion at the runway threshold by integrating runway demand with operational capability to handle the airborne and surface traffic load.

24.3 Human Factors

Human factors efforts in developing prototypes, conducting simulations, assessing human-system performance against baselines, integrating workstations, and training for new systems include:

- Designing new automation interfaces for tower controller traffic management tasks, such as monitoring, routing, and timing surface movement

- Establishing methods and procedures for new enabling technologies, such as voice recognition and synthetic voice, to reduce controller head-down time and facilitate routine repetitive tasks

- Designing the human interface for integrated displays of information related to weather, surface movement, arrival and departure management, and system status

- Integrating automated operations related to flight data processing, tactical conflict detection, and improved spacing and sequencing

- Increasing efficiency of controller tasks, such as departure clearance services, flight plan data access, and landing and taxi control operations

- Allocating roles and responsibilities for collaborative controller planning and decisionmaking under various system constraints and alternatives.

24.4 Transition

Figure 24-8 depicts the transition to the ATCT architecture. For a significant period, the current ATCT systems will be sustained. The E-IDS will be deployed to consolidate status and display devices in the tower cab. All high-activity towers will be equipped with IDS, followed by installation of IDS in moderate-activity towers. The high-activity towers will receive the upgraded TDW, which will integrate the platform for the majority of applications in ATCTs.

24.5 Costs

The FAA estimated costs for facilities and equipment (F&E), operations (OPS), and research, engineering, and development (R,E&D) for the
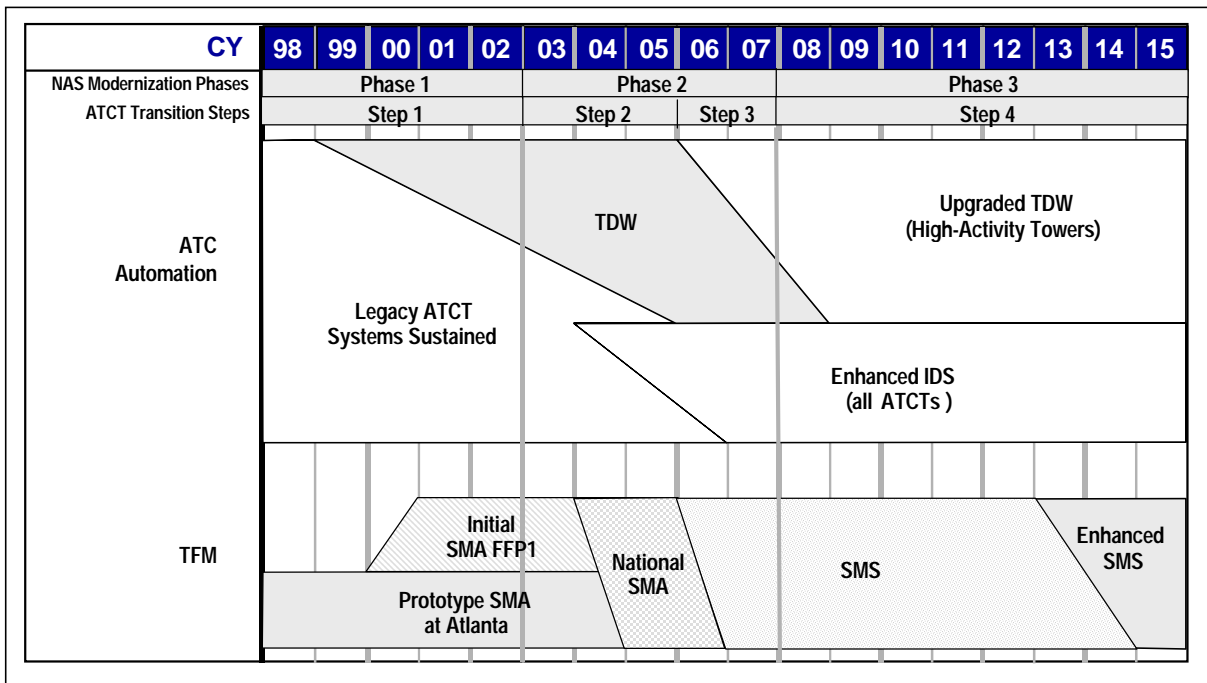
Figure 24-8. Airport Traffic Control Tower Architecture Transition

tower automation architecture from 1998 through 2015 are presented in constant FY98 dollars in Figure 24-9. This excludes costs associated with DBRITE replacement in the STARS program (see Section 23, Terminal), LAAS landing systems (see Section 15, Navigation, Landing, and Lighting Systems), or weather systems (see Section 26, Aviation Weather).

24.6 Watch Items

A Tower and Airport Surface program (e.g., automation, information display system (IDS), TDWs) is needed. The ATCT enhancements are highly dependent on developments in other domains. The FAA recognized the need to assess its ability to implement and integrate the DSSs on the tower displays, and that there is yet to be any
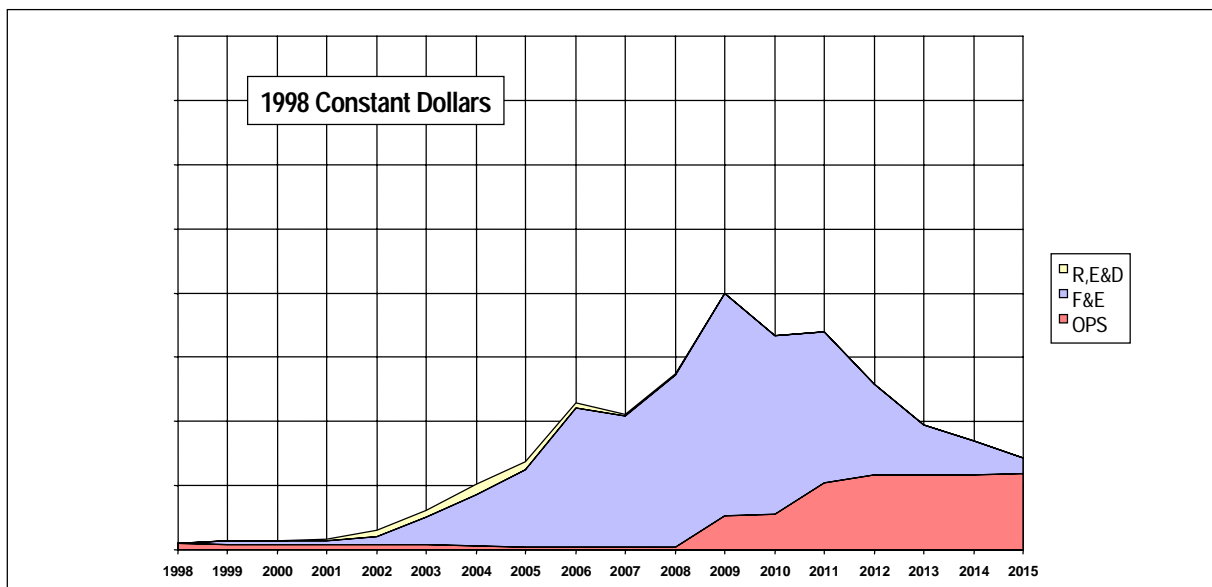

Figure 24-9. Estimated Airport Traffic Control Tower Automation Architecture Costs

commitment made to implementing these capabilities. Surface movement guidance and control require significant integration to provide the needed services without distracting from the need to keep most of a controller's workload focused on visually observing traffic.